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DWARFMISTLETOE SURVEY IN NORTHEASTERN WASHINGTON

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ABSTRACT

Plot and roadside surveys on the Colville National Forest and adjacent private lands in northeastern Washington revealed widespread, severe infection by dwarfmistletoe in Douglas-fir and western larch stands. Infection in ponderosa pine stands was limited mostly to the southern part of the surveyed area. Many of the lodgepole pine stands, especially in the north, were infected. Infection in other species was infrequently encountered.

INTRODUCTION

Many foresters are aware of the abundance of dwarfmistletoe in northeastern Washington. However, no specific information is available to show the magnitude of the problem. The effect of dwarfmistletoe on the host is the primary concern of foresters. Before the full impact of this parasite on growth and yield can be determined, full information about its distribution and severity of infection is needed.

This paper reports surveys made to determine distribution and abundance of dwarfmistletoe (Arceuthobium spp.) in northeastern Washington. A roadside and sample plot survey was completed on each ranger district except Sullivan Lake in the Colville National Forest. A plot survey was made 2 years later on about 100,000 acres of timber land under the ownership of Deer Park Pine Industries, Potlatch Forests, Inc.[2/] These private lands are widely dispersed in Ferry and Stevens Counties and the western part of Pend Oreille County both within and south of the Colville National Forest (fig. 1).

This paper reports the survey results and also some other information on dwarfmistletoe conditions in parts of northeastern Washington that were not surveyed. This latter information was obtained from observations made in the area over a period of years, largely during travel scheduled for other purposes, and during the course of other work.

ROADSIDE SURVEY

The roadside survey in Colville National Forest consisted of traveling a portion of the roads in each ranger district at about 10 miles per hour. Frequent stops were made to examine the stands. Intermingled and adjacent alienated lands were included.

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2/ Throughout this report, "private lands" refers to this ownership.

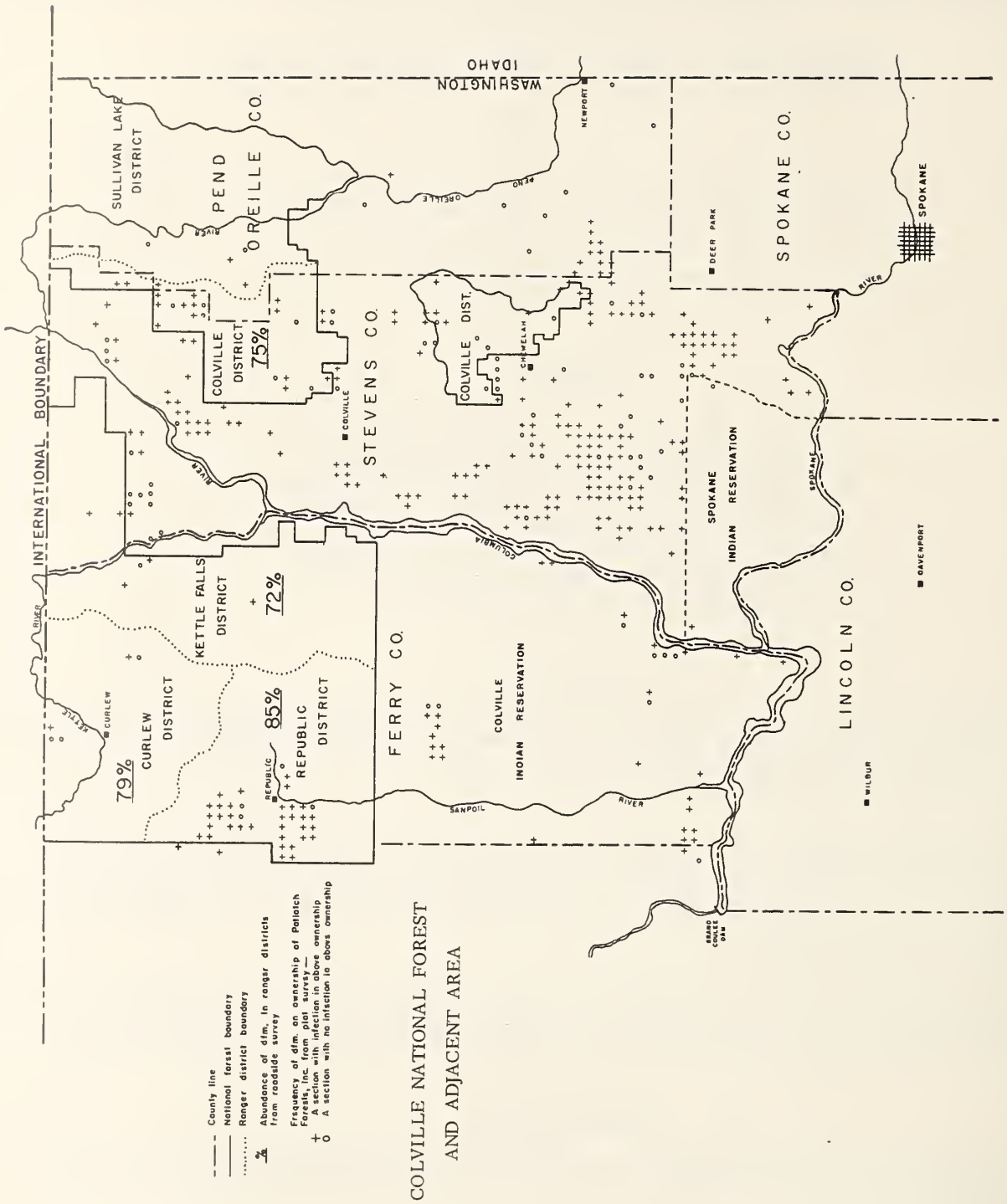

Figure 1.--Percentage of roadside stands infected by dwarfmistletoe, by ranger districts, Colville National Forest, and frequency of dwarfmistletoe in ownership of Potlatch Forests, Inc., northeastern Washington.

Roadside stands were classified according to the extent and degree of dwarfmistletoe infection by species and by different types of stands. The presence of dwarfmistletoe was confirmed by typical signs, such as plants of the parasite, witches'-brooms, and cankers. All tree species were observed continuously for infection. However, detailed information was recorded only when Douglas-fir, western larch, or lodgepole pine comprised 10 percent or more of the stand. Whenever the parasite was found in other coniferous species the approximate location and extent of the infected area were recorded on an outline map.

The record included:

Degree of dwarfmistletoe infection	
Free	Stand free of dwarfmistletoe
Light	Less than one-third of the trees infected
Moderate	One-third to two-thirds of the trees infected
Heavy	More than two-thirds of the trees infected

Type of stand	
Nonmerchantable	
Class I	Even-aged stands of saplings or poles with no overstory
Merchantable	
Class II	Mature or virgin stands
Class III	Regenerated partial burns with overstory of fire residuals
Class IV	Cutover stands with overstory of cutting residuals

Dwarfmistletoe occurrence and stand type were observed on a continuous strip one or one-half chain wide, depending on stand density, along the right-hand side of the road. Odometer readings were taken to the nearest one-tenth mile whenever one of the above conditions changed. In two-storied stands, the degree of infection in the understory was recorded separately from that in the overstory.

PLOT SURVEY

Two separate plot surveys were made, one on Forest Service lands and one on private lands. Techniques used in the two surveys varied.

FOREST SERVICE LANDS

On Forest Service lands, fixed radius sample plots were taken in merchantable Douglas-fir and larch stands known to have infection. Some plots were located within the roadside strips; others were taken along lines run perpendicular to the roadside. Most plots were one-fifth acre. Their distribution varied depending on the various stand conditions and on the intensity of sampling considered necessary. In general, roadside plots were one-fourth to one-half mile apart, and line plots were randomly located at the rate of eight per mile of line.

Each merchantable tree on each plot was tallied by species, diameter class, and number of merchantable logs, and was classified in one of six degrees of dwarfmistletoe infection:

0 - dwarfmistletoe free
1 - lightly infected
2 - moderately infected
3 - heavily infected
4 - very heavily infected
5 - dead during past 5 years and showing symptoms or signs of having had dwarfmistletoe

Degree of infection was determined by rating the lower and upper one-half of the crown separately. Each half was rated as either 1 (light), less than one-third of the branches infected, or 2 (heavy), more than one-third of the branches infected. The two figures were added for total rating of the tree. Thus, a class 4 tree (very heavily infected) had heavy infection in both upper and lower crowns.

Immature trees on each plot were tallied by species; by three size classes--large pole, small pole, or sapling; and by two health condition classes--dwarfmistletoe free or dwarfmistletoe infected.

PRIVATE LANDS

Private lands were surveyed by point sampling with a 12.5 basal area factor prism. All timber types and tree size classes in both infected and noninfected stands were sampled. Plots were located near roadsides whenever possible at the rate of ten per section or an equivalent for ownerships smaller than one section. Most roads

were along stream bottoms and to avoid too large a sample of the stream-bottom type, plots usually were established above the road. Plots were alternated on right- and left-hand sides of roads located on slopes and ridges. In ownership that had no roads, a compass and pacing traverse was run. The traverse started at the most accessible corner and ran diagonally across the ownership. A plot was established every 8 chains along the traverse line.

All live trees 1 inch d.b.h. or larger and all dead trees 11 inches d.b.h. or larger (but dead for only 5 years or less) were tallied on each plot. These individual trees were classified in one of four degrees of infection:

Free	Dwarfmistletoe free
Light	Less than one-fourth of crown infected
Moderate	At least one-fourth but less than one-half the crown infected
Heavy	One-half or more of crown infected

RESULTS OF ROADSIDE SURVEY

Abundance of infected stands on each ranger district was determined from roadside surveys along 551.4 miles of road (table 1 and fig. 1). Dwarfmistletoe was found along 426.6 miles, or in 77 percent of the stands traversed. Infection was 76 percent of the roadside distance traveled in Douglas-fir stands, 86 percent in western larch, and 25 percent in lodgepole pine.

Table 1.--Incidence of dwarfmistletoe shown by roadside survey in Colville National Forest, including intermingled and adjacent alienated lands

Species and ranger district	Miles of roadside strip	Proportion of roadside miles traveled in--				
		Dwarfmistletoe infected stands				Dwarf-mistletoe free stands
		Light	Moderate	Heavy	Total	
		Percent				
Douglas-fir						
Republic	143.9	24	28	34	86	14
Curlew	78.8	26	24	28	78	22
Kettle Falls	129.4	19	32	27	78	22
Colville	61.6	18	17	13	48	52
All districts	413.7	22	27	27	76	24
Western larch						
Republic	55.0	10	22	52	84	16
Curlew	20.2	18	21	39	78	22
Kettle Falls	129.0	7	28	57	92	8
Colville	81.3	12	23	44	79	21
All districts	285.5	10	25	51	86	14
Lodgepole pine						
Republic	21.9	10	16	17	43	57
Curlew	9.6	13	0	4	17	83
Kettle Falls	89.3	6	9	8	23	77
Colville	61.6	8	10	5	23	77
All districts	182.4	7	10	8	25	75
All species 1/						
Republic	160.3	21	27	37	85	15
Curlew	87.8	27	24	28	79	21
Kettle Falls	199.6	15	22	35	72	28
Colville	103.7	16	24	34	74	26
All districts	551.4	19	24	34	77	23

1/ Values include 0.3 mile of infected subalpine fir in the Republic District, 1.7 miles of infected ponderosa pine in the Kettle Falls District, and 6.4 miles of infected grand fir in the Colville District.

Incidence of infected stands by tree species was about the same regardless of ranger district with two exceptions: frequency of infected Douglas-fir stands was 30 to 38 percent less in the Colville District than in other districts, and infected stands of lodgepole pine were about twice as common in the Republic District as in other districts. In the entire forest, about one-third of the infected Douglas-fir and lodgepole stands and more than half the infected larch stands were heavily infected.

Frequency of infection in the overstory of various types of merchantable stands was reasonably uniform, and a high percentage of the merchantable stands was infected. Infection was about as common in virgin mature stands as in stands having merchantable overstory trees left by fire or cutting (table 2). Infection in the overstory markedly influences infection in the understory. Whenever the overstory was infected, the understory usually was. Conversely, sapling and pole stands that had no overstory were usually free. Dwarfmistletoe in the Douglas-fir and larch understory of merchantable stands was six to seven times more frequent than in sapling and pole stands having no overstory.

Table 2.--Abundance of dwarfmistletoe in different types of stands of Douglas-fir and western larch, Colville National Forest

Tree species	Incidence of dwarfmistletoe by various types of stands 1/				
	Nonmerchantable:	Merchantable			
		Overstory			Understory
	Class I (saplings and poles)	Class II (mature)	Class III (Fire residuals):	Class IV (cutover)	Classes II, III, IV
	Percent				
Douglas-fir	9	77	60	87	64
Western larch	12	95	93	94	81

1/ Based on the distance traveled in infected stands expressed as a percentage of the total distance traveled in each type of stand.

The Sullivan Lake District contained fewer dwarfmistletoe infected stands than other districts of the Colville National Forest. In the 3 days of scouting on this district, no infection was found in Douglas-fir, but infected lodgepole pine stands were found in three localities. Although several stands contained infected larch, uninfected larch stands were more common here than in the rest of the forest. Limited data based on 49.4 miles traversed showed that 53 percent of the larch stands along roadsides were infected.

In addition to the widespread distribution of the Douglas-fir, western larch, and lodgepole pine dwarfmistletoes on the Colville National Forest, we found several infected stands of grand fir and one infected stand each of ponderosa pine and subalpine fir.

General distribution and extent of dwarfmistletoe were observed in unsurveyed parts of northeastern Washington, including Spokane and Lincoln Counties and much of southern Pend Oreille, Stevens, and Ferry Counties, and the Colville and Spokane Indian Reservations. Only one stand of infected ponderosa pine was found in the Colville National Forest, but this species is frequently attacked south of this forest. Considerable infection occurs in the ponderosa pine stands along the Spokane River valley and the forested benchlands above the valley bottom from the Idaho line to the Columbia River. Many stands in the Colville and Spokane Indian Reservations are infected. Most of this area has rather sporadic distribution of ponderosa pine dwarfmistletoe (i.e., small acreages that are alternately infected and free), but several fairly extensive timber stands are infected.

Sporadic distribution of lodgepole pine and Douglas-fir dwarfmistletoes was observed throughout the forested area of Spokane, Lincoln, and the southern parts of Pend Oreille, Stevens, and Ferry Counties. Except for several Douglas-fir stands in the northern part of the Colville Indian Reservation, no large continuous areas of either lodgepole pine or fir were infected. Wherever western larch occurs in this unsurveyed area, some infection can usually be found.

RESULTS OF PLOT SURVEY

FOREST SERVICE LANDS

Four hundred sample plots, all in infected stands, were established in merchantable Douglas-fir and western larch stands at 33 locations in the Colville Forest. Results of roadside plots and line plots showed no appreciable difference. Therefore, data from the two types of plots have been combined and summarized (tables 3 and 4).

Table 3.--Incidence of dwarfmistletoe in merchantable stand volume on 400 sample plots in infected Douglas-fir and larch stands, Colville National Forest

Species and ranger district	Total volume 1/	Dwarfmistletoe infected volume				Dwarf-mistletoe free volume
		Light to moderate	Heavy to very heavy	Dead 2/	Total	
	M bd.ft.	Percent				
Douglas-fir						
Republic	211.3	48	31	5	84	16
Curlew	105.0	39	28	6	73	27
Kettle Falls	66.5	46	21	17	84	16
Colville	27.7	61	3	1	65	35
All districts	410.5	46	27	7	80	20
Western larch						
Republic	120.1	24	59	11	94	6
Curlew	69.6	29	35	29	93	7
Kettle Falls	37.5	38	44	9	91	9
Colville	41.5	55	30	4	89	11
All districts	268.7	32	46	14	92	8

1/ Based on board-foot log volume, Scribner Decimal C. 2/ Does not represent total dead volume but only mortality for which dwarfmistletoe was considered a major factor.

The plots contained more than two-thirds million bd. ft. of merchantable sized Douglas-fir and larch. Infected trees made up 85 percent of this volume. By species, 80 percent of the Douglas-fir volume and 92 percent of the larch volume were in infected trees (table 3). About one-third of the Douglas-fir volume and three-fifths of the larch volume were in heavily infected or dead mistletoed trees. Infected Douglas-fir trees accounted for 4,776 bd. ft. per acre and infected larch trees for 3,613 bd. ft. per acre.

Seven percent of the total Douglas-fir volume and 14 percent of the total larch volume were in recently killed trees that had dwarfmistletoe. These percentages of dead volume varied considerably among ranger districts. Tree volume in this category was based on dead standing trees having bark and limbs fairly intact, or recent windthrows that showed symptoms or signs of dwarfmistletoe infection prior to death.

The amount of infection decreased as tree size decreased but was appreciable even in saplings (table 4). For example, in Douglas-fir, 74, 51, 41, and 28 percent of the trees were infected in the mature, large pole, small pole, and sapling size classes, respectively. Decreasing incidence of dwarfmistletoe with smaller tree size was usual in both tree species on all ranger districts.

Table 4.--Incidence of dwarfmistletoe in immature trees in 400 sample plots in infected Douglas-fir and larch stands, Colville National Forest

Species and ranger district	Classes of immature trees infected with dwarfmistletoe		
	Large poles	Small poles	Saplings
	Percent		
Douglas-fir			
Republic	51 (4) 1/	40 (4)	26 (1)
Curlew	57 (2)	47 (5)	41 (2)
Kettle Falls	54 (9)	44 (4)	27 (1)
Colville	36 (0)	25 (2)	9 (2)
All districts	51 (4)	41 (4)	28 (2)
Western larch			
Republic	79 (13)	58 (5)	33 (1)
Curlew	67 (11)	56 (8)	36 (0)
Kettle Falls	70 (4)	50 (8)	29 (0)
Colville	91 (19)	87 (19)	80 (0)
All districts	76 (11)	60 (8)	39 (<1)

1/ Percentages in parentheses refer to mortality; for example, 51 percent of the large Douglas-fir poles were infected; 4 percent of the 51 percent were dead and showed signs of having been infected by dwarfmistletoe.

PRIVATE LANDS

Data were taken on 1,690 variable plots that included a sample of 11,596 trees. Approximately 102,900 acres, or 99 percent of the ownership, were sampled. This ownership occurred in a total of 362 sections. Seventy-eight percent of these sections had dwarfmistletoe in one or more tree species (fig. 1).

Three tree species (ponderosa pine, Douglas-fir, and western larch) made up 75 percent of total basal area and 85 percent of total board-foot volume. They also were the species in which most of the dwarfmistletoe occurred.

Western larch was most heavily infected in respect to both basal area and volume. Infection was lowest in ponderosa pine and intermediate in Douglas-fir (table 5). The Douglas-fir and larch dwarfmistletoes were present throughout the area surveyed. However, no infection in ponderosa pine was found in the northern part of the area.

Table 5.--Incidence of dwarfmistletoe in living trees as determined from 1,690 sample locations taken in the ownership of Deer Park Industries, Potlatch Forests, Inc.

Tree species	Dwarfmistletoe infected				Dwarfmistletoe free
	Light	Moderate	Heavy	Total	
	Percent				
	By basal area [1]				
Ponderosa pine	5	3	8	16	84
Douglas-fir	17	7	15	39	61
Western larch	17	8	34	59	41
Lodgepole pine	3	1	2	6	94
Other species	1	1	0	2	98
All species	11	5	13	29	71
	By cubic-foot volume [1]				
Ponderosa pine	5	2	8	15	85
Douglas-fir	19	8	17	44	56
Western larch	17	9	41	67	33
Lodgepole pine	3	1	1	5	95
Other species	1	1	0	2	98
All species	11	6	15	32	68
	By board-foot volume [2]				
Ponderosa pine	5	2	8	15	85
Douglas-fir	23	13	24	60	40
Western larch	15	11	59	85	15
Lodgepole pine	3	0	1	4	96
Other species	2	1	0	3	97
All species	13	8	24	45	55

[1] Includes all trees 1 inch d.b.h. and larger. [2] Includes trees 11 inches d.b.h. and larger, based on Scribner Decimal C and total merchantable height.

This distinct northern limit of the occurrence of dwarfmistletoe in ponderosa pine confirms the findings shown by the roadside and plot surveys made on National Forest lands. Except in one stand, no dwarfmistletoe was found in ponderosa pine in Pend Oreille County or in the northern portions of Stevens and Ferry Counties.

Damage to the merchantable stands is shown by the amount of board-foot volume infected (table 5). Fifteen percent of the ponderosa pine, 60 percent of the Douglas-fir, and 85 percent of the larch board-foot volumes were infected. Most important, 45 percent of the total board-foot volume on all plots combined was in infected trees. Volumes of infected trees in other species were negligible.

Using basal area as the most representative measure of infection in all tree size classes, we found total infection for all species to be 29 percent. By species, 16, 39, and 59 percent of the ponderosa pine, Douglas-fir, and larch, respectively, were infected (table 5). About one-half of the basal area in infected trees was heavily infected.

Comparisons between dead trees in the uninfected and the infected categories are shown in table 6. In the recently dead ponderosa pine trees, 35 percent of the board-foot volume was in trees infected at the time of death. Corresponding percentages for Douglas-fir and larch were 53 and 98 percent, respectively. The direct effects of dwarfmistletoe on tree death are difficult to measure. However, the relationships shown above suggest that dwarfmistletoe apparently contributed to mortality, especially in larch.

Table 6.--Incidence of dwarfmistletoe in recently dead trees as determined from 1,690 sample locations taken in the ownership of Deer Park Industries, Potlatch Forests, Inc.

Tree species	Dead trees infected with dwarfmistletoe					
	By basal area 1/		By cu.-ft. vol. 1/		By bd.-ft. vol. 2/	
	Infected	Free	Infected	Free	Infected	Free
	Percent					
Ponderosa pine	35	65	41	59	35	65
Douglas-fir	53	47	58	42	53	47
Western larch	79	21	90	10	98	2
Lodgepole pine	2	98	2	98	0	100
Other species	0	100	0	100	0	100
All species	42	58	49	51	42	58

1/ Includes all trees 1 inch d.b.h. and larger. 2/ Includes trees 11 inches d.b.h. and larger, based on Scribner Decimal C and total merchantable height.

COMPARISON OF ROADSIDE AND PLOT SURVEYS

The distribution and abundance of dwarfmistletoe observed from a roadside survey generally agree with the percentage of trees and volume infected as shown by sample plots. The roadside survey in the Colville National Forest showed that 78 percent of the merchantable Douglas-fir stands along roadsides was infected. The plot survey showed that in infected stands 74 percent of the merchantable trees containing 80 percent of the board-foot volume is infected. Correspondingly, 94 percent of the merchantable larch stands along roadsides had dwarfmistletoe and 90 percent of the trees and 92 percent of the volume in these stands were infected.

The board-foot volume in infected trees is probably about the same on both ownerships for Douglas-fir and larch. The data show a 10 to 20 percent higher occurrence of dwarfmistletoe in these species on National Forest land than on private lands. This would be expected because only infected stands were sampled in the National Forest, whereas all stands, regardless of infection, were sampled on private lands.

SUMMARY

Distribution and abundance of dwarfmistletoe in northeastern Washington were determined from two separate but similar surveys. Dwarfmistletoes were widespread in this area in three tree species: Douglas-fir, western larch, and ponderosa pine. Infection in Douglas-fir and western larch is found almost throughout the area. Infection in ponderosa pine is common in the southern part of the territory but almost absent in the northern part. Much of the lodgepole pine, especially in the north, was infected. Dwarfmistletoe has attacked several other tree species but is generally only a minor problem in them.

Larch dwarfmistletoe was found along 86 percent of the 286 miles of roadside strip traversed in larch stands. Corresponding values for Douglas-fir and lodgepole pine were 76 percent of the 414 miles and 25 percent of 182 miles, respectively.

Surveys showed that an infected overstory markedly affects the amount of infection in the understory. Dwarfmistletoe in Douglas-fir and larch overstory of merchantable stands was six to seven times more prevalent than in sapling and pole stands with no overstory.

A plot survey in infected Douglas-fir and larch stands on National Forest land showed 80 percent of the Douglas-fir board-foot volume and 92 percent of the larch board-foot volume were in infected trees. Merchantable trees killed by dwarfmistletoe accounted for 7 and 14 percent of the total volumes in Douglas-fir and larch, respectively. In nonmerchantable trees on these plots, 41 percent of the Douglas-fir and 62 percent of the larch trees were infected.

A survey on private lands within and south of the Colville National Forest, including both infected and noninfected stands, showed that 45 percent of the total board-foot volume was in infected trees. By species, infected trees accounted for 15 percent of the ponderosa pine, 85 percent of the western larch, and 60 percent of the Douglas-fir board-foot volumes. Amount of infection based on basal area and cubic-foot volume also was determined. The positive correlation between tree mortality and infection suggests that dwarfmistletoe contributed to mortality.